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MORBIDITY AND MORTALITY WEEKLY REPORT

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Exposure of Passengers and Flight Crew to *Mycobacterium tuberculosis* on Commercial Aircraft, 1992–1995

From January 1993 through February 1995, CDC and state health departments completed investigations of six instances in which passengers or flight crew traveled on commercial aircraft while infectious with tuberculosis (TB). All six of these investigations involved symptomatic TB patients with acid-fast bacillus (AFB) smear-positive cavitary pulmonary TB, who were highly infectious at the time of the flight(s). In two instances, *Mycobacterium tuberculosis* isolated from the index patients was resistant to both isoniazid and rifampin; organisms isolated from other cases were susceptible to all antituberculous medications. In addition, in two instances, the index patients were aware of their TB at the time of travel and were in transit to the United States to obtain medical care. However, in none of six instances were the airlines aware of the TB in these passengers. This report summarizes the investigations by CDC and state health departments and provides guidance about notification of passengers and flight crew if an exposure to TB occurs during travel on commercial aircraft.

Investigation 1. A flight attendant had documented tuberculin skin test (TST) conversion in 1989 but had not received preventive therapy (1). While working on numerous domestic and international flights from May through October 1992, she developed a progressively severe cough, and pulmonary TB was diagnosed in November 1992. An investigation by CDC included TSTs of 212 flight crew who worked with the flight attendant from May through October and 247 flight crew who had not been exposed to her. The prevalence of positive TSTs among flight crew exposed to the flight attendant during August through October was higher than among crew exposed from May through June (25.6% versus 4.1%; $p < 0.01$) and among unexposed flight crew (1.6%; $p < 0.01$). TST conversion was documented in two crew members exposed only in August and October, respectively. TST positivity and conversions were not associated with aircraft type, but were associated with cumulative flight time exposure of >12 hours. TST reactivity was assessed in 59 passengers registered in the airline's frequent flyer program who had traveled on flights worked by the flight attendant with TB during August–October. Of these, four (6.7%) were TST positive; all had traveled in October. The investigation indicated that the index patient transmitted *M. tuberculosis* to other members of the flight crew, but evidence of transmission to passengers was inconclusive (1).

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Investigation 2. During 1993, the Minnesota Department of Health conducted an investigation of a foreign-born (i.e., born outside the United States or Canada) passenger with pulmonary TB who traveled in the first class section of an aircraft during a 9-hour flight from London to Minneapolis in December 1992 (2). Of the 343 crew and passengers on the aircraft, TST results were obtained for 59 (61%) of 97 U.S. citizens and 20 (8%) of 246 non-U.S. citizens. TSTs were positive for eight (10%) persons—all of whom had received bacille Calmette-Guérin (BCG) vaccine or had a history of past exposure to *M. tuberculosis*. The investigation indicated no evidence of transmission of TB during the flight (2).

Investigation 3. In March 1993, a foreign-born passenger with pulmonary TB traveled on a 1½-hour flight from Mexico to San Francisco. This investigation included efforts by the San Francisco Department of Public Health to obtain information by mail from all 92 passengers on the flight; 17 persons could not be contacted because of invalid addresses. TSTs were positive in 10 (45%) of the 22 persons who were contacted and completed TST screening; nine of these TST-positive persons were born outside the United States. The other was a 75-year-old passenger who may have become infected with *M. tuberculosis* while residing outside the United States or during a period when TB was prevalent in the United States. The San Francisco Department of Public Health found no conclusive evidence of transmission during this flight.

Investigation 4. In March 1993, CDC investigated a case of pulmonary TB in a refugee who traveled on flights from Frankfurt, Germany, to New York City (8½ hours) and then to Cleveland, Ohio (1½ hours) (3). Of 219 passengers and flight crew on both flights, 169 (77%) were U.S. residents; 142 (84%) of the U.S. residents completed TST screening. TSTs were positive in 32 (23%), including five persons who had converted from negative on initial postexposure testing to positive on follow-up testing. Of the 32 TST-positive persons, 29 had received BCG or were born and had resided in countries where TB is endemic, including all five TST converters. The five passengers who were TST converters had been seated in sections throughout the plane. Because none of the U.S.-born passengers on this flight had TST conversions, the investigation indicated that, although transmission could not be excluded, the positive TSTs and conversions probably were associated with prior *M. tuberculosis* infection, a boosted immune response from prior exposure to TB, or prior BCG vaccination.

Investigation 5. In March 1994, a U.S. citizen with pulmonary TB and an underlying immune disorder who had resided long term in Asia traveled on flights from Taiwan to Tokyo (3 hours), to Seattle (9 hours), to Minneapolis (3 hours), and to Wisconsin (½ hour). Of 661 passengers on these four flights, 345 (52%) were U.S. residents. The Wisconsin Division of Health contacted the 345 U.S. residents and received reports about TST results from 87 (25%) persons; of these, 14 (17%) had a positive TST. All 14 persons had been seated more than five rows away from the index patient; nine of these persons had been born in Asia (including two with a known prior positive TST). Of the five who were TST-positive and U.S.-born, one was known to have had a positive TST previously, two had resided in a country with increased endemic risk for TB, and two were aged ≥75 years. The investigation indicated that, although transmission of TB during flights could not be excluded, the positive TSTs may have resulted from prior *M. tuberculosis* infection.

Investigation 6. In April 1994, a foreign-born passenger with pulmonary TB traveled on flights from Honolulu to Chicago (7 hours, 50 minutes) and to Baltimore (2 hours),

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where she lived with friends for 1 month. During that month, her symptoms intensified; she returned to Hawaii by the same route. Investigation in Baltimore determined that TST conversion had occurred in the 22-month-old child of her friends. The four flights included a total of 925 passengers and crew who were U.S. residents, of whom 755 (82%) completed TST screening; of these, 713 (94%) were U.S.-born. The investigation by CDC indicated no evidence of transmission on the flight from Honolulu to Chicago or the flight from Chicago to Baltimore. Of the 113 persons who had traveled on the flight from Baltimore to Chicago, TSTs were positive in three (3%), including two who were foreign-born. However, of the 257 persons who traveled from Chicago to Honolulu (8 hours, 38 minutes), TSTs were positive in 15 (6%), including six who had converted; two of these six persons apparently had a boosted immune response, while the other four had been seated in the same section of the plane as the index patient. Because of TST conversions among U.S.-born passengers, the investigation indicated that passenger-to-passenger transmission of *M. tuberculosis* probably had occurred.

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Editorial Note: The investigations described in this report were undertaken to determine whether exposure to persons with infectious pulmonary TB was associated with transmission of *M. tuberculosis* to others traveling on the same aircraft. Two of these investigations indicated that transmission occurred (investigation 1, from flight attendant to other flight crew, and investigation 6, from passenger to passenger). In investigation 6, transmission occurred on the return to Hawaii, when the index passenger was most symptomatic and on the longest flight. All persons with TST conversions were seated in the same section of the aircraft as the index passenger, suggesting that transmission was associated with seating proximity. Because the origins of all foreign-born passengers were countries in which TB is endemic and/or where BCG vaccine is routinely used, TST results from these passengers do not reliably represent recent infection. Among persons who could be contacted during the other investigations, low response rates constrained the interpretation of findings from those investigations.

Investigations such as those described in this report are subject to two substantial constraints. First, because the investigation may be initiated several weeks to months following the time of the flight and exposure, passengers may not be readily located. With the exception of persons who are enrolled in frequent flyer programs, airline companies do not routinely maintain residence addresses or telephone numbers for passengers. Second, the time elapsed between the flight and when public health authorities and airline companies become aware of an exposure and when passengers are notified and tested limits the use of TSTs to assess for conversion. To interpret prevalent positive TST results, other possible reasons for a positive TST result must be considered, including prior exposure to TB, residence or birth in countries in which TB is endemic, and BCG vaccination. In the United States, an esti-

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mated 4%–6% of the total population is TST positive (4), and in developing countries, the estimated prevalence of *M. tuberculosis* infection ranges from 19.4% (in the Eastern Mediterranean region) to 43.8% (in the Western Pacific region) (5).

To prevent exposures to TB aboard aircraft, when travel is necessary, persons known to have infectious TB should travel by private transportation (i.e., not by commercial aircraft or other commercial carrier). In addition, patients with infectious TB should at least be sputum smear-negative for AFB before being placed in indoor environments conducive to transmission (6). Three negative sputum smear examinations of specimens on separate days in a person on effective anti-TB therapy indicate an extremely low potential for transmission, and a negative culture virtually precludes potential for transmission (6). Decisions about a TB patient's infectiousness and ability to travel should be made on an individual basis.

The risk for *M. tuberculosis* transmission on an aircraft does not appear to be greater than in other confined spaces. Based on a consideration of current evidence indicating low risk for transmission of TB on aircraft, need for notification of passengers and flight crew members may be guided by three criteria. First, the person with TB was infectious at the time of the flight. Persons who, at the time of flight, are symptomatic with AFB smear-positive, cavitary pulmonary TB or laryngeal TB are most likely to be infectious. Evidence of transmission to household and other close contacts also indicates infectiousness. Second, exposure was prolonged (e.g., duration of flight exceeded 8 hours). Third, priority should be given to notifying passengers and flight crew who were at greatest risk for exposure based on proximity to the index passenger (for example, depending on the aircraft design, proximity may be defined as seating or working in the same cabin section as the infected passenger). Notification should be conducted by the airline in coordination with local and state TB-control programs.

References

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